Development of Benchmarks and Weighting Systems for Building Environmental Assessment Methods: Opportunities of a Participatory Approach

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Abstract

Sustainable construction is a terms that emerged with the introduction of the concept of sustainable development in construction. Therefore, sustainable construction embraces socio-economic, cultural, biophysical, technical and process-orientated aspects of construction practice and activities.

The progress towards sustainability in construction may be assessed by implementation of good practice in building developments. Therefore, building environmental assessment methods are valuable tools of indicating such a progress as well as promoting sustainable approaches in construction.

An effective building environmental assessment method requires definition of explicit benchmarks and weightings. These should take into account environmental, social and economic contexts of building developments.

As the existing building environmental assessment methods largely ignore socio-economic impacts of building developments, the implementation of a participatory approach in the development of benchmarks and weighting systems could greatly contribute to a more meaningful incorporation of social and economic aspects into the assessment process. Furthermore, the participation of stakeholders in establishing qualitative benchmarks and weights should increase the credibility of such a process.

The participatory approach could allow for education of all stakeholders about the potential environmental, social and economic consequences of their decisions and

actions, which is so vital for achieving their commitment to strive towards sustainable construction.

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1 Introduction

1.1 Sustainable Development

In 1987, the World Commission on Environment and Development (WCED) introduced and defined the concept of sustainable development. The commission stated that sustainable development "*meets the needs of the present without compromising the ability of future generations to meet their own needs*" (Brundtland Report, WCED, 1987).

The notion of sustainable development (sustainability) aims at reconciling economic growth with social progress within the carrying capacity of the surrounding environment. Hill and Bowen (1997) argue that sustainable development emphasizes the social and economic goals of the society, especially in the developing world. Progress towards sustainability also implies maintaining or improving the well being of humans and ecosystems (Hardi and Zdan, 1997).

Sustainable development has been deeply rooted within the environmental movement (Hill and Bowen, 1997). In addition, it emerges as an important trend within other spheres of human development, for instance the construction industry.

The construction sector has a considerable impact on the biophysical environment as it consumes great amounts of renewable and non-renewable resources. It also contributes to other global environmental concerns such as the greenhouse effect or ozone layer depletion. On a local scale, the encroaching built environment often changes natural ecosystems and interrupts the dynamic equilibrium within lifesupporting systems. Development of the construction industry has a direct impact on the living standards of communities, and contributes a considerable share to the national economy. As construction affects all aspects of life, it is crucial that future development of this sector integrates environmental, social and economic considerations.

The main problems that face the construction industry today include rising global and local environmental concerns and a need for new economic strategies. Furthermore, the perspective of limits-to-growth (i.e. where pollution, environmental degradation and depletion of natural resources are perceived as barriers to the growth) provides an additional motivation to implement responsible development. According to Hill and Bowen (1997) the adoption of the sustainability agenda in the construction sector has led to the introduction of a new term – 'sustainable construction'.

1.2 Sustainable Construction

Sustainable construction embraces socio-economic, cultural, biophysical, technical and process-orientated aspects of construction practice and activities (Hill and Bowen, 1997). It addresses a building as a system, as well as the building's impacts at all stages of the building lifecycle (i.e. planning and design, manufacturing of building materials, construction, and operation and decommissioning) (Barker and Kaatz, 2001).

One of the indications of the progress towards sustainable development consists in the implementation of good practice. It may be measured using techniques of relative evaluation (Morse *et al.*, 2001). This task is often conducted using an environmental assessment method to evaluate sustainable practices within building developments. Therefore, in the broader view, building environmental assessment methods are perceived as tools to measure progress towards sustainability, and to promote sustainable construction practices.

1.3 Building Environmental Assessment Methods

The major role of building environmental assessment methods is to help decision-makers to implement sustainability in the built environment and during construction (Graham, 1998). Existing building environmental assessment methods measure improvements in the environmental performance of buildings relative to typical practice (Barker and Kaatz, 2001). Therefore they provide a means of identifying desired levels of building performance. In addition, most building assessment tools encourage environmental efficiency and enhance market competitiveness by green labelling (Barker and Kaatz, 2001)

More specifically, building environmental assessment methods evaluate building performance with respect to a broad range of environmental considerations organized into assessment criteria (e.g. resource use, ecological loading and health impacts) (Cole, 2000).

The assessment process itself consists of three modules (Cole, 2000). The fist part of the assessment, called the 'input module', involves collection of environmental information and measurement of building performance.

The next part of the assessment, namely the 'assessment module', entails an evaluation of building environmental performance against a set of chosen criteria. It is achieved by comparison of the assessment information from the input module to reference values (i.e. benchmarks) (Nibel, 2001).

The 'output module' is the final part of the assessment process. It allows for interpretation of assessment results and their communication to all key stakeholders (i.e. decision-makers, engineers, architects, contractors, building owners, and occupants). During this stage a weighting system is used to indicate the relative importance of the assessment criteria.

A set of explicit benchmarks and a weighting system are both critical components of a building assessment method, based as it is on a relative evaluation of building environmental performance. The choice of benchmarks determines the points of reference (i.e. what the building performance is compared to), and therefore the outcome of the assessment. Likewise, selection of weights has great influence on the final score of the assessment. According to Curvell *et al.* (1999), the weighting system may have a greater impact on the outcome of the assessment than all the performance data gathered for the assessment.

It is argued in this paper that the development of benchmarks and weights (a weighting system) for a building environmental assessment method are crucial stages that ultimately determine the meaningfulness and effectiveness of such a method.

Furthermore, implementation of a participatory approach in the development of benchmarks and weighting system would enhance the incorporation of social and economic aspects into the assessment process.

A participatory approach is essential for integrating principles of sustainable development in the construction sector. The commonly used building environmental assessment tools, which not only assess the building performance but also indirectly provide information on the sustainability of the construction industry, focus mainly on the biophysical aspects of the building developments. This contrasts with the premises of sustainability, as little attention is paid in such tools to the socio-economic impacts of building investments. There is a dispute as to what type of building assessment is sufficient to address the sustainability of the construction industry (i.e. Levin, 1996).

1.4 Green and Sustainable Assessment of Building

It is possible to distinguish between 'green' and 'sustainable' building assessment methods. Green methods are based on a relative assessment, and they measure improvements in environmental building performance in relation to current typical practice or requirements (Cole, 1999). Sustainable methods are based on absolute assessment, which measures the absolute amount of energy and mass flows associated with buildings (Cole, 1999).

Due to practical reasons the most commonly used building assessment tools evaluate a building in relative terms by comparison to standard practice or to a set of established norms and standards. The need to accommodate a broader range of assessment criteria (i.e. biophysical, social and economic) in the green building tools has already been recognised, and the changes have been incorporated in the new versions of internationally established tools, such as the Green Building Tool (GBTool) or Building Research Establishment Environmental Assessment Method (BREEAM). As the building assessment tools evolve, more attention is paid to socio-economic aspects of building production and performance.

1.5 Main Points Addressed in the Paper

The main points that will be addressed in this paper include a discussion of green and sustainable building assessment methods – their aims and characteristics. Likewise, the article will provide description of benchmarks and weighting systems emphasizing their importance, and presenting the common practices. This will be followed by discussion on how a participatory approach in the development of these two components of a building assessment method may further contribute towards sustainability in construction.

2 Methodology

This paper covers an aspect of a group project report written by the author and Greg Barker titled *Environmental Sustainability Assessment Methods for Buildings in South Africa* for the Department of Environmental and Geographical Science, University of Cape Town. This paper is based on an extensive literature review on building environmental assessment methods, sustainable development and sustainable construction as well as personal communication with the researchers in the field of sustainable construction.

3 Green and Sustainable Assessments in Construction

Building environmental assessment methods have been developed in order to evaluate the environmental performance of buildings. They also contribute to the objectives of sustainability in construction by indicating good practice. In addition, building environmental assessment methods provide a common and verifiable set of criteria. This allows building designers and developers (as well as owners) to demonstrate their efforts in striving for high environmental performance (Barker and Kaatz, 2001).

Most of the currently used building assessment methods address a broad spectrum of biophysical aspects of the environment and are therefore referred to as 'green' assessment methods. It is not only the omission of socio-economic factors but also the relative nature of such assessments that make them insufficient to indicate progress towards sustainability in construction.

According to Levin (1996), assessment of improvements over current practice is not an effective contribution towards sustainability. Levin (1996) further argues that the only meaningful evaluation of sustainability must be based on measurement of the distance to targets. The targets should be derived for each individual assessment and account for levels of resources consumption, pollution, and land encroachment. Development of targets must be guided by the context of population, and economic and technological development projections (Levin, 1996). Cole (1999) also agrees that sustainable building environmental assessment requires generation of explicit environmental, socio-economic and technical performance targets for building developments.

Sustainable assessment requires information on the absolute impacts of a building development. This entails placing the building development within the assimilative capacity of ecosystems at the local, regional and global scales. In addition, it is necessary to quantify the complex links between building activities and the environment (Cole, 1999). Another issue that needs to be addressed is the ability to assess sustainable construction at the level of individual buildings. Cole *et al.* (2000) advocate an extension of the assessment boundaries to embrace the community or region in which a building is located.

Apart from the above challenges, there are numerous practical obstacles associated with sustainability assessments such as availability of appropriate environmental information, validity of future development projections, changing nature of social values, cost and lack of appropriate assessment techniques. Therefore, green assessment continues to be more acceptable to building developers and assessment practitioners (Cole and Larsson, 2000). The underlying assumption in implementing green assessment is that the cumulative positive environmental impact of continually improving the environmental performance of individual buildings will be sufficient to fully address environmental problems (Cole, 1999).

3.1 Characteristics of Green Building Assessment Methods

The range of environmental (i.e. biophysical) issues assessed by green methods is considerably broader than that necessary for sustainability assessment. This is due to the fact that the building assessment aims to encourage developers and designers to aspire to higher environmental performance in buildings (Barker and Kaatz, 2001). The most commonly addressed environmental issues are presented in *Table 1.*

Table 1. Environmental issues commonly addressed by green building assessment methods

Environmental Issues
Water consumption and conservation (collection of rainwater, greywater recycling)
Energy consumption and conservation (e.g. embodied and/or operational energy, contribution of renewable sources of energy)
Materials selection and use (e.g. low-emitting materials, implementation of reduction, reuse and recycling measures)
Indoor environmental quality (e.g. thermal comfort, humidity, radon control)
On-site facilities (recycling provisions, on-site wastewater management)
Site conditions (e.g. site ecology, landscaping)
Contextual factors (e.g. municipal infrastructure, public transportation)
Building lifecycle (i.e. planning, design, construction management, efficiency and controllability of building systems during operational phase, decommissioning plans)

Sources: Levin (1997); Howard (2000)

There is however a consensus among sustainable construction researchers and practitioners that the protection of the environment through green building assessments will be only meaningful if the assessment is extended to also cover socio-economic considerations (Hill, 1998; Chau *et al.*, 2000; Cole *at al.*, 2000).

3.2 Incorporation of 'Sustainable Approaches' in Green Assessment Methods

The attempts to incorporate aspects of sustainability in green assessments have already been demonstrated, as the internationally established assessment **methods** continue to evolve. The 'sustainable approaches' included in green assessments comprise the following:

- Life cycle analysis of buildings and materials;
- Systems approach in the assessment of a building;
- Promotion of eco-efficiency;
- Assessment of contextual factors (i.e. interaction of the development with existing built environment, accessibility of municipal infrastructure, public transport, etc.);
- Impacts of the building development on the socio-economic environment (i.e. reference to local economy, accommodation of cultural differences);
- Assessment of life cycle cost of the development.

Most of these approaches are found in the internationally established assessment methods such as GBTool, BREEAM or LEED (Leadership in Energy and Environmental Design). However, the coverage of socio-economic aspects of building developments is still lacking in such methods.

The latest version of GBTool tries to go further than simply integrating sustainable approaches into green assessment. The GBTool framework has been supplemented with a set of sustainable indicators (see *Table 2*). These indicators help to assess a building performance in absolute terms, characterize sustainable practices and facilitate international comparability of sustainable construction practices (Cole and Larsson, 2000).

Table 2. Environmental Sustainability Indicators (ESIs) included in GBC 2000

Sustainable indicators
Net annual consumption of primary energy for building operations
Annual green house gases (GHG) emissions from building operations
Net area of land consumed for building and related works
Net annual consumption of water from building operations

Source: Cole and Larsson, 2000; pp. 214

GBTool presents efforts to combine green and sustainable building assessments. This seems to be the most appropriate approach, as a green building assessment method has a limited ability to indicate progress towards sustainability in construction. On the other hand, there are numerous practical difficulties with developing and implementing sustainable building assessments. Nevertheless, it is necessary to establish a set of benchmarks according to which it would be possible to define standard, good and outstanding practice in construction. Benchmarks provide a basis for relative assessment in green building assessment methods, and are used indirectly in sustainable assessments, as targets should not be set below the standard practice.

4 Benchmarking in Building Environmental Assessment Methods

Building environmental assessment methods evaluate building environmental performance and building practices in relation to standard (typical) practice or good practice. The requirement of relative assessment is to declare a benchmark for each building performance criterion (Cole, 1999). Therefore, in order to provide a proper basis for building environmental assessment, it is necessary to develop a set of explicit benchmarks.

Benchmarks can be defined as measures of comparison in the building environmental assessment for quantitative or qualitative values (criteria). Benchmarks comprise the following (Cole, 2000):

- Environmental standards and regulations (e.g. norms on greenhouse gases emissions);
- Established industry norms (e.g. American Society of Heating, Refrigerating and Air-Conditioning Engineers -ASHRAE);
- Best practice guidance (material use, water use, rainwater control, etc., building management practices, design strategies);
- Government statutes, local by-laws and context (construction related environmental impacts, such as noise abatement, supply and removal of temporary water); or
- Set of targets developed for the purposes of the building assessment.

Development of benchmarks for a building environmental assessment method is critical as they influence the effectiveness of a building assessment. Moreover, the choice of appropriate benchmarks, guided by technological progress, helps to set realistically challenging targets for construction practitioners. This is an important aspect, as building assessment tools should indicate opportunities for enhancement in construction practices, and consequently bring about continuous improvement – a requirement of sustainable development. Therefore benchmarks may be used to set targets and guide strategy towards improvements (Garnett and Pickrell, 2000).

4.1 Development of Benchmarks

Garnett and Pirckrell (2000) argue that in the development of any environmental assessment method an agreement on benchmarking is a priority. Therefore, great attention and effort should be allocated to the development of benchmarks.

Development of benchmarks for a building environmental assessment may be based on adaptation of the Reading Model of benchmarking process presented by Garnett and Pickrell (2000; pp. 57). The Reading Model consists of the following steps:

1. The need for change;
2. Decision to benchmark;
3. Identifying what to benchmark;
4. Design of the benchmarking study;
5. Data collection and analysis;
6. Implementation;

7. The feedback.

The first step of developing benchmarks requires establishment of a vision of how a building environmental assessment may contribute towards sustainability in the construction sector. It is important to agree whether the developers/building owners should strive towards the best achievable practice or simply perform better than the standard. This is a strategic decision and factors to be taken into account include economic situation, environmental awareness of the stakeholders, and commitment to sustainable construction. The building environmental assessment method must be an agent of change and therefore include demanding criteria that need to be balanced with a number of constraints. These constraints may include the feasibility of introducing new technological improvements and local socio-economic and environmental conditions (Todd and Geissler, 1999).

Benchmarking requires defining standard, good and outstanding practice. Defining a standard practice is a very difficult task and has to account for such factors as (Todd and Geissler, 1999):

- Design and construction context (including standard professional practice in a given region, patterns of building use, construction financing practices, etc.);
- Infrastructure context (including water and energy supply systems, waste management systems, manufacturing industry for building materials, local transportation systems, etc.);

- Cultural context (including political/administrative and legal considerations, historical experience, etc.);
- Cost-effectiveness, feasibility, practicality and acceptability of various measures.

Likewise, defining a good or advanced practice is also determined by similar factors. According to Todd and Geissler (1999), it is however necessary to decide whether the choice will depend on the best building practice that may be achieved under given socio-economic and administrative constraints, on technical feasibility, or will be dictated by the requirements of sustainability.

Ideally, sustainable construction practices should be guided by the requirements of sustainability. It means that benchmarks would comprise a set of targets corresponding to each of the building development goals.

Basing the definition of good and outstanding practice on what is technically feasible in a given region is too simplistic. As the nature of building assessments is still largely voluntary, the developers/owners will tend to choose strategies that are cost-effective, practical and not necessarily 'challenging' with regard to environmental protection. At the same time, technology does not necessary respond to social needs and cultural context.

Therefore, the option that is chosen most often is a definition of good practice according to the socio-economic and administrative options and opportunities. The choice of suitable benchmarks is determined either by consideration of practicality and costs, or by basing the hypothetical best condition on the available technology. This raises a question whether an average standard building in the specified area or an agreed generic standard should be used as the baseline condition (Barker and Kaatz, 2001).

After deciding what should be benchmarked (standard or/and good and outstanding practice), and having established all assessment criteria, it is necessary to design appropriate terms of reference for the study process. This requires determination of measurement rules and boundaries of the study. It is important to decide what kind of benchmarks will be used for which assessment criteria (i.e. standards, norms, regulations, or expert judgement).

Building environmental assessment methods comprise both qualitative and quantitative criteria (see *Table 3*). While it is relatively easy to develop benchmarks for quantitative assessment features, it becomes highly problematic to derive benchmarks for qualitative criteria. Usually this problem is overcome using a considerable judgment based on the environmental performance of standard buildings or on the sustainability goals.

Collection of data and their analysis is followed by the implementation and development of benchmarks. Continuous monitoring is an essential part of the process. It means that benchmarks must be updated according to advances in technological progress, changes in a socio-economic context, changes in the sustainability agenda, rising environmental awareness, as well as in the understanding of consequences of human impacts and activities. Comparison of benchmarks may also provide additional insights into the progress towards sustainability in the construction sector.

Table 3. Examples of qualitative and quantitative features of the assessment process

Quantitative Features	Qualitative Features
Energy/fuel use (Btu, kWh, fuels, $)	***Does building work within site context***
Comfort (ASHRAE 'standard' temperature, humidity, etc.)	***Aesthetic quality of a space***
	Comfort feel of a space
Materials waste (tons, surplus, $)	***Productivity of occupants***
Lighting levels (Lux, Lumens, Lumen/W)	***Lighting quality***
Cost of improvements ($, % difference)	

Source: Howard, 2000 (http://www.nrg-builder.com/eeba2000/tsld002)

4.3 Establishment of Benchmarks in Existing Building Assessment Tools

Development of benchmarks is not an easy process. As mentioned before, the main difficulties associated with benchmarks include the definition of typical, good and advanced (outstanding) practice in construction. These vary from place to place, especially between the developed and developing countries. The reasons for these differences include availability of technology, cultural values and socio-economic requirements. Due to these reasons benchmarks developed for the purposes of BREEAM or LEED may not be applicable in countries such as South Africa or

Poland. Therefore customisation and adaptation of building environmental assessment tools to specific conditions of the place of their application is crucial.

This approach of customisation is explicit in the Green Building Challenge (GBC). GBC is an international collaboration effort (Cole and Larsson, 2000) to develop a consensus-based green building assessment framework. The GBC process resulted in the establishment of GBTool that can be easily modified by national teams to cater for specific environmental priorities in particular countries or regions. Therefore, GBTool allows for a regional variation in standard, good and advanced practice, cultural and socio-economic environments, and sensitivity of the receiving ecosystems.

One of the crucial objectives of GBC was to establish international benchmarks for building performance while respecting regional and technical diversity (Todd and Geissler, 1999). The first attempts of GBC (i.e. GBC'98) introduced the concept of a reference building to facilitate the establishment of benchmark performance levels (Cole, 1999). A reference building for GBTool is a building of the same size and type as the case study building, designed assuming industry norms. The national teams were required to characterize benchmarks for that building type and region across all applicable performance issues (e.g. energy use, water use). National teams also relied on figures derived from national databases or other statistical sources (e.g. variations in local climate conditions, occupancy patterns, operating schedules, etc.) (Cole, 1999).

Benchmarking remains an accepted approach in GBC 2000. However GBTool 2000 does not require a reference building for benchmarking. National teams must simply determine and justify chosen benchmarks. In defining appropriate benchmarks, quantifiable issues (e.g. energy use, water use, etc.) are assumed to be either minimum code requirements or a typical practice. Qualitative criteria require judgment, and default benchmarks for these criteria are simply a declaration of what would be considered to be a typical condition or typical practice for the specific building type in the region (Cole and Larsson, 2000).

4.4 Normalisation of Assessment Information

When comparing building performance against declared benchmarks it is necessary to use consistent performance measures for each assessment criterion. This means that performance data for the case study building must be available in the same units as the benchmark performance. Therefore performance information is often normalized for the purposes of comparison (for instance, energy use per m^2 per degree-day to account for variations in climate) (Cole, 1999). According to Cole and Larsson (2000), although the definition of a reference building was problematic, this approach had an important advantage, as normalization was less critical (due to the similar size of the building, use and location) (Cole and Larsson, 2000).

The choice of suitable benchmarks for building assessments has a great impact on the overall results of such assessments. Another factor of crucial importance for the outcomes of building assessments is a weighting system to prioritise criteria used in the assessment (i.e. decide the relative importance of building environmental issues).

5 Weighting Systems

Weighting plays a significant role in a building environmental assessment system. Weighting is linked with the summarising and communicating of performance results, as it facilitates reduction in the assessment scores to a manageable number of output profiles. Therefore, the selection and application of weights greatly influences the overall building performance profile and score (Cole and Larsson, 2000).

The establishment of a weighting system for an environmental assessment makes it possible to determine the relative importance of various environmental issues (e.g. energy consumption vs. water consumption, soil erosion, habitat destruction or wastewater production). Cole (1999) suggests that understanding of the relative importance of environmental criteria should be based on the final endpoints. Therefore, it is necessary to fully comprehend the potential impacts of a building development, and not only analyse changes in quality and quantity of environmental media (e.g. water, air, soil). Weighting will continue to be a subjective process as environmental problems are complex and interconnected, and not entirely understood.

The importance and relevance of building environmental criteria vary from place to place, and tend to change when moving from a local to global perspective (Todd and Geissler, 1999). Therefore, the development of a weighting system should account for environmental, social and economic factors in a given region, as well as respond to global concerns (Todd and Geissler, 1999; Levin, 1997).

The relevance of environmental criteria to a building assessment method in a given region may be determined by the availability of resources and a carrying capacity of the natural environment, economic factors and social acceptance. Whereas, weighting of the importance is based on potential impacts that each criterion might have on the environment and human well-being, both locally and globally (Todd and Geissler, 1999).

Apart from indicating the relevance and importance of building environmental issues, a weighting system also reflects the intent of stakeholders to deal with sustainability issues in the built environment. Chau *et al.* (2000) argue that a weighting system needs to cater for the practical and cost implications of achieving better building performance. Moreover, weighting should attempt to reconcile issues of short-term investment value with medium- and long-term performance for occupants and the environment (Bordass and Leaman,). Therefore, the development of a weighting system should begin with establishing an appropriate strategy that would balance short-, medium- and long-term goals of sustainable construction with regard to environmental, social and economic considerations.

5.1 Development of Weighting Systems

In order to develop an environmental weighting system it is necessary to define criteria for weighting, choose measurement scales and define scaling increments. In addition, it is important to decide how credits should be rewarded in relation to the efforts made in achieving higher levels of building environmental performance. For instance, the choice of so-called 'incentive weighting' will result in assigning more credits or points for a given increment in performance as the overall performance level increases (Chau et al., 2000). Westerberg (2000) indicated the same dilemma with regard to qualitative weighting. According to Westerberg (2000), a linear scale does not correspond to most people's mental scale, which is supposed to be logarithmic. As it is difficult to justify weights for qualitative impacts, Westerberg (2000) stated that establishment of a weighting system should be always supplemented with appropriate motivation. This helps with the interpretation of evaluation results and with the changing weights according to another rationale or context.

The importance of building environmental impacts is most commonly assessed with regard to such criteria as an impact's reversibility, duration and mitigation opportunities. It is essential to establish the degree to which any development action or impact may affect the functioning of life support systems, environmental goods, services of special character, of limited supply, or essentially irreplaceable (Preston *et al.*, 1992), and weight the impact accordingly. Therefore, determining the importance of building environmental impacts must include the following aspects (Levin, 1997):

1. The spatial scale of the impact (global, regional, local – the larger the scale the worse the impact);
2. The severity of the hazard (more toxic, dangerous, damaging being worse);
3. The degree of exposure (well-sequestered substances being of less concern than readily mobilized substances);
4. The penalty for being wrong (longer remediation times of more concern);

5. The status of affected sinks/receptors (sensitivity of the receiving environment).

5.1.1 Weightings Based on the Characteristics of Impacts

This approach is employed in a building environmental assessment method called EcoEffect. Here, the building environmental problems are weighted with regard to their detrimental consequences for human health, ecosystems and natural resources in a global and long-term perspective (Westerberg, 2000).

The weighting criteria include such aspects as the extent, intensity and reversibility. Therefore, greater weights are assigned to more extensive, intensive and less reversible environmental impacts. The definition of an impact's extent is based on the amount of an emitted pollutant, the accumulated exploitation of a natural resource or the number of individuals affected by an environmental effect. The intensity corresponds to toxicity or harmfulness for the individual or ecosystem, and is based on the concept of Disability Adjusted Life Years (DALY) developed by the World Health Organization (WHO) (Westerberg, 2000). Reversibility refers to the inherent possibility to recover after exposure or when the environmental effect ceases (Westerberg, 2000).

Due to its nature, this weighting system is based on expert-judgments alone. It is not a sustainable approach, which requires the broad participation of all stakeholders in the development of weights for environmental problems.

Other bases for weighting environmental impacts may include the following (Glaumann, 2001):

- Money (willingness to pay for prevention or counteraction, costs of elimination, loss of potential production);
- Damages (what nature can sustain, documented damages, projections and scenarios); or
- Opinions (panel of experts, group of stakeholders, public opinion).

5.1.2 Weightings Based on Environmental Damage

The environmental weighting system based on the concept of damage, is an example of a more scientific derivation of weights. According to Glaumann (2001), such a system has the potential to improve the accuracy of weights as the knowledge of building environmental impacts increases.

In a weighting procedure described by Glaumann (2001), the environmental damages were divided into three groups, namely, harm to humans, harm to ecosystems and depletion of natural resources. Environmental damages were characterized by intensity, duration and extent. The intensity required a qualitative judgment of the degree of caused harm, whereas duration and extent could be quantified and varied from local and short lasting, to global and long lasting (Glaumann, 2001).

The damages were presented in the form of graphical curves. The weighting process involved collection of data on the environmental problems such as emissions, state of the environment, environmental effects and damages caused by the actual impact.

The curves were compared in order to find time lags, peaks and duration. With a full damage curve, i.e. showing the spell from start to cease, it was possible to estimate the total damage and compare it with corresponding values for other environmental problems (Glaumann, 2001).

Glaumann (2001) argues that weights assigned according to any other basis may become irrelevant within a short period of time due to a sudden economic shift or a change in the relevance of environmental concerns. However, it is one of the principles of sustainable development to modify goals, targets and priorities according to the varying nature of the surrounding biophysical and socio-economic environments.

Due to this principle, a consensus-based approach to the establishment of an environmental weighting system becomes more popular in practice. Such an approach is based on the consensus view between all levels of decision-makers about the relative importance of different environmental issues (Dickie and Howard, 2000). This is an example of a weighting system that is based on opinions of the stakeholders.

5.1.1 A Consensus-based Weighting System

A consensus-based weighting of different sustainability issues in construction was carried out by the Building Research Establishment (BRE) in 1997/98. The results of that study were subsequently used in the environmental weighting system in the BREEAM assessment method (Baldwin *et al.*, 1998).

The process began with extensive research on the key issues of sustainable construction. The identified issues were divided into three themes: economic, environmental and social, each with a few sub-themes. The consultation process that followed the research stage employed a panel of professionals from the following groups (Dickie and Howard, 2000):

- Government policy makers and researchers;
- Construction professionals;
- Construction materials producers and manufacturers;
- Property and institutional investors;
- Environmental activists and lobbyists;
- Local authority policy makers and planners;
- Academics and researchers.

In the first part of the weighting process, the participants were asked to assign 20 points between all issues within each theme. Afterwards they proceeded with scoring the relative importance of the themes and sub-themes. This was necessary to compare different impacts on the basis of a single score (Dickie and Howard, 2000).

Dickie and Howard (2000) argue that the results of this process are subjective and time-dependent. Therefore, the process will need to be repeated on the regular basis. This corresponds with the principles of sustainability. An additional advantage of a consensus-based approach is its participatory nature that brings together the professional judgements of experts as well as concerns, insights and interests of all other stakeholders.

Graham (1998) emphasises that the absence of an explicit weighting of environmental problems may lead to ad hoc choices by decision-makers or an ineffective strategy towards sustainable development. Yet, weighting of building environmental problems is a very difficult task. There is a general lack of consensus in assigning relative importance to environmental issues between scientist, decision-makers, different lobbying groups and the general public. In addition, it is often problematic to prioritise between global and local environmental concerns. Other reasons include a limited understanding of how a building development contributes to environmental problems, and the effectiveness of mitigation measures. Cost-effectiveness of mitigation measures must be also taken into account as well as the agenda of clients (Environmental Building News, 1995).

The development of a meaningful building environmental assessment method, with a set of appropriate benchmarks and an established weighting system, significantly influences the effectiveness of efforts made to attain sustainable construction using building environmental assessment tools. However, the most important condition to achieve sustainability in construction requires an explicit environmental commitment by all stakeholders to implement the principles of sustainable development.

6 Participatory Approaches

A broad participation of all stakeholders in any assessment process is an important aspect of sustainability assessments (Hardi and Zdan, 1997). As one of the aims of a building environmental assessment is to indicate the progress towards sustainable construction, the development of assessment methods should have a participatory character (i.e. involve all stakeholders). This is a necessary condition to achieve the vision and goals of sustainable construction.

Designers of building environmental assessment methods choose specific assessment frameworks and the categories of data and information that are included. These choices reflect their values, biases, interests and insights (Hardi and Zdan, 1997). However, building environmental assessment methods must respond to the needs, interests and concerns of all stakeholders. A participatory approach in the development (and updating) of benchmarks and a weighting system may allow for the incorporation of these aspects in the building assessment process.

6.1 Participation of Stakeholders in the Development of Benchmarks and Weightings

As definitions of benchmarks and weights (especially those of qualitative nature) are based on subjective judgments, a participatory approach provides greater credibility to the entire process. Moreover, it is important to recognize that value-based judgments vary among individuals, cultures and locations (Levin, 1996). Therefore a participatory development of benchmarks and weights may enhance recognition of diverse and changing values held by all stakeholders (Hardi and Zdan, 1997).

Glaumann (2001) argues that a drawback with weightings based on the opinions of stakeholders and the public is that they are not entirely based on environmental impacts and therefore may change quickly. However, according to Hardi and Zdan (1997) it is impossible to reflect the diverse and changing nature of values held across society without a broad participation of the stakeholders. It is likely that the development of weightings that exclude opinions of all stakeholders will respond to the short- term needs of a particular interest group.

In addition, the inclusion of all stakeholders in the development of a weighting system may result in a greater commitment on their side to the principles and vision of sustainable construction.

6.2 Structure of the Participation Process

A participatory approach implies the need for a consensus-based process. Such a process requires co-operation between all stakeholders in reaching results, which have benefits for all. The most important stages of the participation process include the following (www.partnerships.org.uk):

- Situation assessment;
- Clarification of the purpose, values and visions;
- Distribution of roles;
- Commitment to the process;
- Communication network;
- Development of criteria;

- Negotiation;
- Making decisions.

The first stage involves identification of all stakeholders, which in the case of building environmental methods would include (but not be limited to) the representatives of regional and local authorities, urban planners, environmental specialists, building designers and architects, engineers, manufacturers, contractors, developers, building owners, and building end-users. All these participants bring to the process their own interests and concerns, which should be clearly communicated. This facilitates the recognition of potential barriers to the process.

After the situation assessment has been completed it is possible to proceed with establishing the vision and goals of the participation process. It is important that all participants fully understand the actual goals and values underlying the process, as well as the outcomes to be achieved. In addition, all participants should acknowledge their own responsibilities during the process, as well as with regard to their future actions. This is crucial in order to achieve a full commitment from the participants to the principles of sustainable construction.

The next stages of the participation process require establishing a communication network, which will facilitate the development of criteria (e.g., for the purposes of benchmarking or weighting building environmental impacts). This is inevitably linked with negotiations and reaching a final consensus on the issues under discussion. The last stage the participation process involves the making of decisions (e.g. establishing benchmarks or the relative importance of building environmental issues).

Although participatory approaches are always challenging, their results are more sustainable especially with regard to environmental problems. They allow for the continuous education of society on the environmental costs and benefits of development actions, as well as for the incorporation of social and economic considerations in the decision-making.

6.3 Participatory Approaches in the Establishment of Benchmarks and Weightings for Building Assessments in South Africa

The benefits and opportunities of a participatory approach have been widely recognised in South Africa – a country of great social, economic and environmental diversity. The example of South Africa Energy and Demand Efficiency Standard (SAEDES) illustrates a process that was based on a broad participation of the stakeholders.

SAEDES was developed by the South African Department of Minerals and Energy (DME) in cooperation with South African industries, and the U.S. Department of Energy (DOE) in 1998 (Fleming *et al.*). The SAEDES guideline proposes a national mode of acceptable practice for cost, energy and environmentally effective building design, construction, operation and maintenance products, systems and professional service for existing and new commercial buildings (Department of Minerals and Energy, 1999).

The participatory approach implemented in the process of developing SAEDES was manifested in the establishment of a working group and committee which consisted of representatives of building professions, the construction industry, government utility, manufacturing and financial institutions (Fleming *et al.*). In addition, education - a premise underlying a participatory approach, became a crucial element of the entire process.

As mentioned above, the development of SAEDES aimed to educate the stakeholders and the community about the goals of SAEDES. The following groups were targeted during the process (Department of Minerals and Energy, 1999):

- Participants within the commercial building construction community (owners/developers, designers, engineers, mechanical and electrical contractors, and others);
- Building ownership and management community (owners, managers, plant engineers, plant operators, maintenance persons, and others); and
- Financial and real estate professionals.

Moreover, the South African government requested public participation in the review and modifications of SAEDES in three- to five-year cycles (Fleming *et al.*).

It is believed that participation of the stakeholders in the process of developing these energy benchmarks allowed for the incorporation of technical, economic and environmental considerations as well as social values. It also provided educational opportunities through dissemination of energy and environmental information (Department of Minerals and Energy, 1999).

A participatory approach has been also implemented in the Sustainable Building Assessment Tool (SBAT) developed by the South African Council for Scientific and Industrial Research (CSIR). SBAT evaluates sustainability of buildings by assessing building performance with respect to economic, social and environmental criteria (CSIR, 2001).

During each assessment process, the identified stakeholders (e.g.. the client, building end-users and the design team) are invited to participate in the discussion on the importance of assessment criteria and in the development of sustainability performance targets. The targets are later used as benchmarks against which a building development is evaluated (CSIR, 2001).

Participatory approaches are usually lengthy, costly and challenging. They require conflict management strategies and considerable financial resources for the capacity building and education of participants.

7 Conclusions

Sustainable construction implies the incorporation of environmental, social and economic considerations in the development of this sector. This can be enhanced by assessment of building developments with respect to their environmental, social and economic impacts.

The existing building environmental assessment methods largely ignore the socio-economic context of building developments and focus on biophysical aspects of building developments. However the need to evaluate social and economic aspects of building developments has been widely recognised.

Apart from modification of assessment frameworks in the building environmental assessment tools to include socio-economic criteria, the implementation of a participatory approach in the development of benchmarks and weighting systems could greatly contribute to a more meaningful incorporation of social and economic aspects into the assessment process. This would also increase the effectiveness of building assessment methods as tools of indicating progress towards sustainability in construction.

It is also important to emphasise that benchmarks should be common for different building assessments method. However they should be customised for the regions of similar environmental conditions (i.e. environmental opportunities and problems) and socio-economic contexts. Therefore, due to enormous diversities that exist in South Africa it might be necessary to establish different sets of benchmarks for standard and good building practice for each province. The same approach should be employed in the development of environmental weightings for building assessments. Hence, participation of all stakeholders in the establishment of benchmarks and weightings could significantly facilitate the process of recognition and incorporation of regional diversities.

Moreover, the participatory approach in the decision-making stages of establishing/updating a building assessment method could help to educate all stakeholders about the potential environmental, social and economic consequences of their decisions and actions. Understanding how the sustainable practices may contribute towards the well-being of society in a short- and long-term perspective is crucial to achieving commitment from all stakeholders to strive towards sustainable construction. Furthermore, the participation of stakeholders in establishing qualitative benchmarks and weights should increase the credibility of such a process, as incorporation of facts and shared values is a prerequisite for transparency and legitimacy.

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